SUBJECT: Review of the Bioastronautics Data Book. (Case 120)

DATE: October 13, 1964

FROM: T. A. Bottomley, Jr.
B. H. Crane
P. R. Knaff
T. S. Luce

SUMMARY

This memorandum summarizes a review of the Bioastronautics Data Book. The objectives of this review were twofold: (1) to compare the data in the Bioastronautics Data Book with the specifications currently set in the Apollo program, and (2) to comment upon ways in which the document can be made more useful as a design guide. In comparing the data in the Bioastronautics Data Book with current specifications for the Apollo program, no significant discrepancies were found. As a design guide, this new volume represents a significant step toward filling an important gap in the information available to aerospace designers. The need for continuous updating and improvements, however, is characteristic of such a task. Several observations and recommendations are made which are intended to enhance the utility of the Bioastronautics Data Book as a design guide. These comments include suggestions for: (1) carrying out a planned data-reduction in some sections, (2) presenting the data in a form most directly applicable to design problems, omitting essentially academic results, (3) citing areas in which important design data is lacking and including the preliminary findings from recent studies in these areas, and (4) updating the existing classes of data to predict more precisely the various parameters for space crews and spacecraft environments.

(NASA-CR-155647) REVIEW OF THE BIOASTRONAUTICS DATA BOOK (Bellcomm, Inc.) 4 p LIMIT NASA

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MEMORANDUM FOR FILE

The purpose of this memorandum is to review the new issue of the NASA Life Sciences Data Book, entitled the Bioastronautics Data Book. The objectives of this review were twofold: (1) to compare the data in the Bioastronautics Data Book with the specifications currently set in the Apollo program, and (2) to comment upon ways in which the document can be made more useful as a design guide. This volume represents the current stage in the development of a bioastronautics data source to be used as a guide by designers of aerospace vehicles and equipment. The new edition contains much useful information, and the compilation of this much applicable data in a single volume is a very valuable tool for the design and future planning of manned space vehicles. The "planned evolution" of this document, moreover, will greatly enhance its potential value in the future, as experience in space flights and in simulation of spacecraft environments increases the reservoir of applicable knowledge. In comparing the data in the Bioastronautics Data Book with the current specifications for the Apollo program, no significant discrepancies were found. The comments and recommendations which are summarized in the following paragraphs are intended to suggest means of improving the document still further and to enhance its utility to designers of aerospace vehicles and equipment.

In some areas of bioastronautics, the applicable data encompasses a wide variety of sources which include detailed enumerations of specific facts. Section 13 of the data book, for example, covers many biological products which must be either stored in the spacecraft, removed by the environmental control system, or tolerated in increasing amounts throughout the mission. Certain of the data have obvious significance, such as the production of urine, sweat and feces. Biological waste products are quantifiable in minute amounts, however, and the available data presents them in an extremely detailed form, as evidenced by the listing of roughly 250 individual constituents of feces and urine or by the three pages of tables devoted to the generation and composition of nails and hair. The data listing numerous organic compounds which are present in minute quantities must be evaluated by experts to establish their significance. It would be valuable to review all of these lists with the general objective of consolidating the information contained in them. The following avenues

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of revision would contribute to this goal; (1) to note items which are most likely to have a detrimental physiological effect upon the crew or which contribute to degrading crew safety, (2) to group entries into classifications having similar properties, (3) to develop summary curves for accumulation as a function of time, and (4) to suggest means of control. Such a planned data reduction in this section and some others (e.g. Section 10, "Energy") could present equally good data in a form more useful for design purposes.

There are areas in which some of the data needed by the aerospace designer is not currently available. Toxicology, weightlessness, and combined stress are obvious examples. In these cases the Bioastronautics Data Book presents a sampling of data which is now available, and the introductory paragraphs caution users against using this data without expert advice. The data book would provide an additional service if it specifically cited the areas in which important design data is lacking. The authors of the various sections are certainly aware of these data lacks, but they are in a better position than the user of this volume to evaluate what data will be needed in their particular areas. In the section on toxicology, for example, data will be needed listing toxic materials, quantifying their accumulation, and giving limiting values for the toxics as a function of time. An indication that such data will be needed and the inclusion of preliminary findings from recent studies are recommended, even though present sources are incomplete. Obviously periodic updating must be a corollary of such a recommendation.

The expert in a discipline often uses theoretical or academic knowledge in deriving pertinent design information. The inclusion of this background knowledge is not necessary, however in a design guide. This observation is applicable to some of the data in the Bioastronautics Data Book. In the section on vision, for example, the data on topography of the eyeball, plan of the retina, optical constants of the eyeball, and rod and cone density distributions were felt to be more of academic interest than of applied interest. The information on hearing, also, is good from a preliminary standpoint, but it would not indicate to the communications engineer what clipping levels to select, what voice bandwidth to use, and what signal-to-noise ratios are required. It is recommended that the data be presented in a form most directly applicable to design problems, and that essentially academic data be omitted.

The data required in space applications involves many conditions which are not usually or easily simulated on earth. The Bioastronautics Data Book can make the most significant contribution to future space work, however, only if its data reflects sources which best predict the influence of the various parameters in a real environment. Several of the sections could benefit from improvement in this regard. In the treatment of environmental temperatures, for example, most of the thermal data presented is valid for air at pressures of one atmosphere under earth-gravity conditions. Free convection, however, will obviously not be present in a gravityless

environment. Furthermore, the effect of convective cooling coefficients for the same mass flow may be significantly different with an environment of oxygen at low pressures because of differences in specific heat and boundary layer effects.

A related criticism is that specialized populations are usually needed for accuracy with respect to performance evaluation, anthropometric dimensions, stress tolerance, and other bioastronautic variables for space crews. A section which might be improved in this general respect is entitled "Size and Motion". This section, which deals with anthropometric and ergometric data, uses military and, sometimes, college populations for reference. The same data classes using the existing astronaut population would be valuable here. It is recommended in all areas that as more data becomes available from space flights or simulations employing astronauts and realistic environments, it should be used to make appropriate revisions where indicated.

In conclusion, the Bioastronautics Data Book represents a significant step toward filling an important gap in the information available to the space vehicle designer. The need for continuous updating and improvements is characteristic of such a task. In order to enhance still further the utility of this volume for aerospace design, the following recommendations have been made: (1) to carry out a planned data reduction in some sections, (2) to cite areas in which important design data is lacking and include the preliminary findings from recent studies in these areas, (3) to present the data in a form most directly applicable to design problems, omitting essentially academic results, and (4) to update the existing classes of data to predict the influence of the various parameters as well as possible for space crews and spacecraft environments.

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